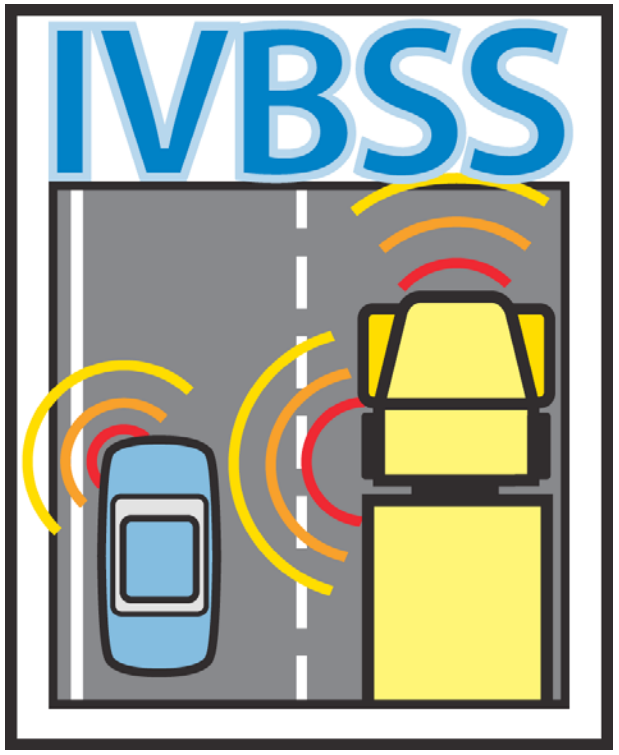

Light Vehicle System Development

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Visteon Corporation

2008 ITS World Congress
Session AM36

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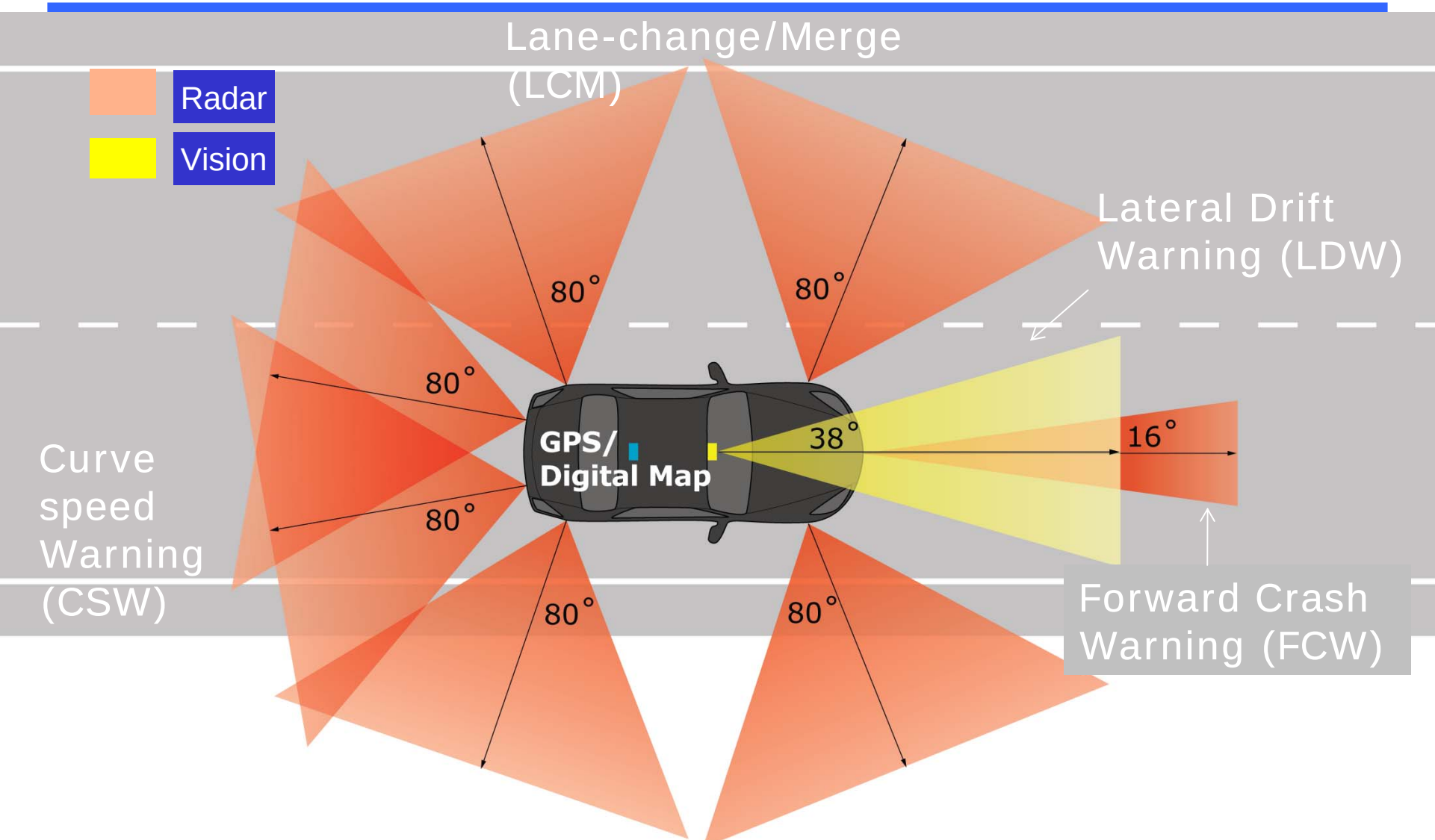
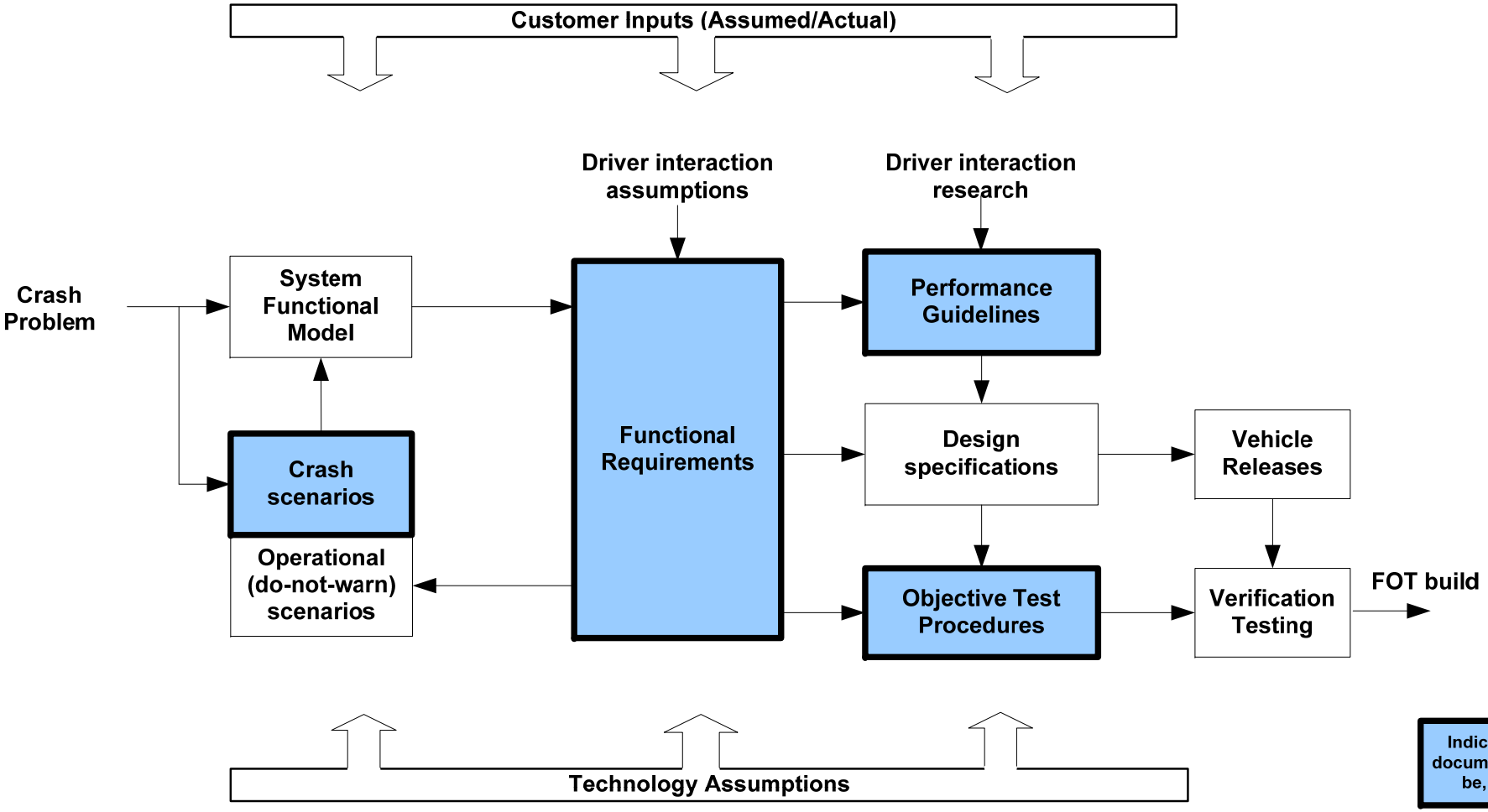
Integrated Safety System



Systems Engineering Process for Light Vehicle



LCM Warning Zones

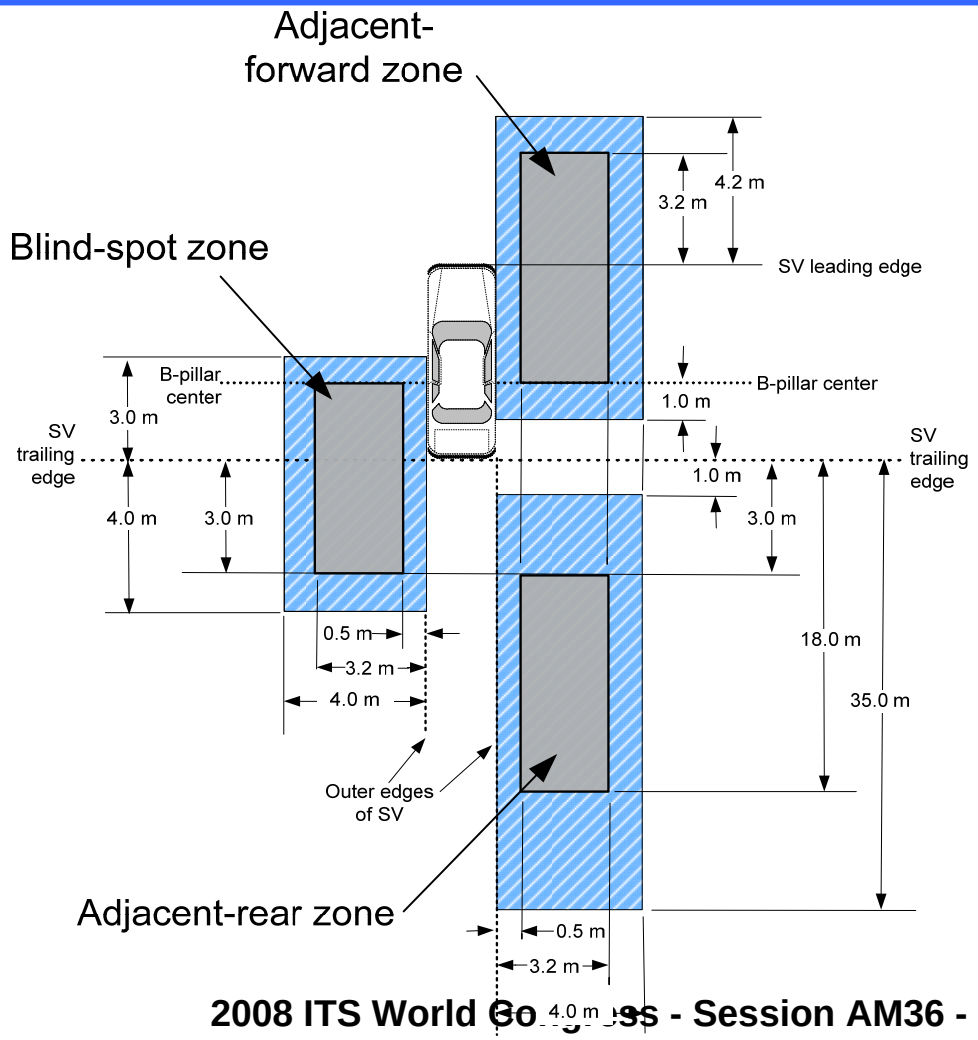


Figure not to scale

All three zones exist on both the left and right size; each zone is shown only on one side here for clarity.

Must-inform regions

May-inform regions

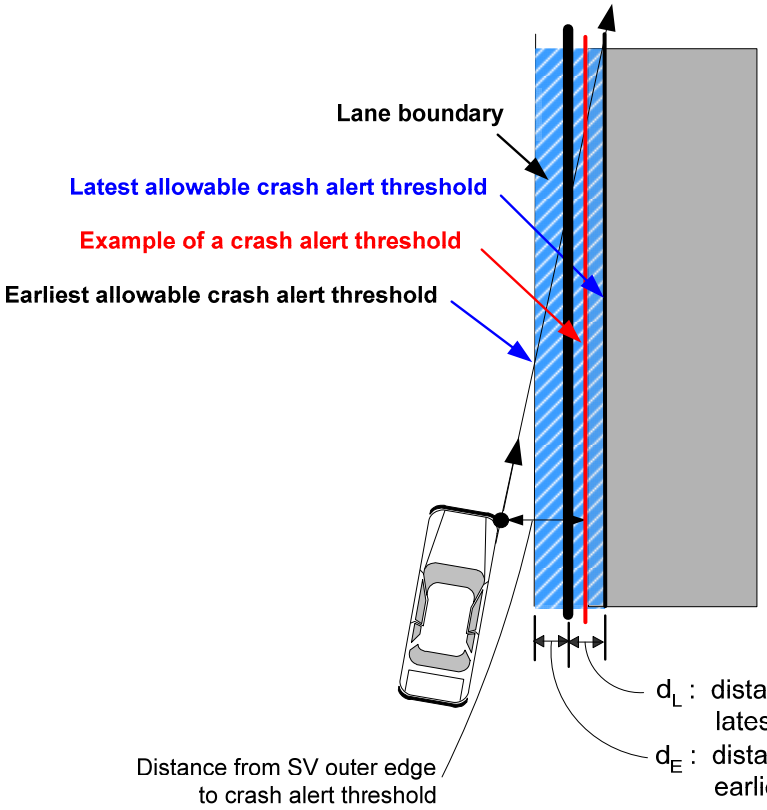
When all other conditions are satisfied - particularly crash alert timing specifications - an LCM crash alert shall be provided when the POV is within the must-inform region. Crash alerts are allowable when the POV is within the may-inform regions.

The POV is considered to be within these regions when:

a) the nearest rear corner of the POV is within the region (for adjacent-forward zone), or
b) the nearest front corner of the POV is within the region (adjacent-rear and blind-spot zones).

LDW Warning Zone

Lateral Drift Crash Alert Thresholds and Zones



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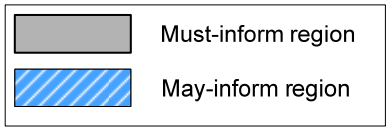
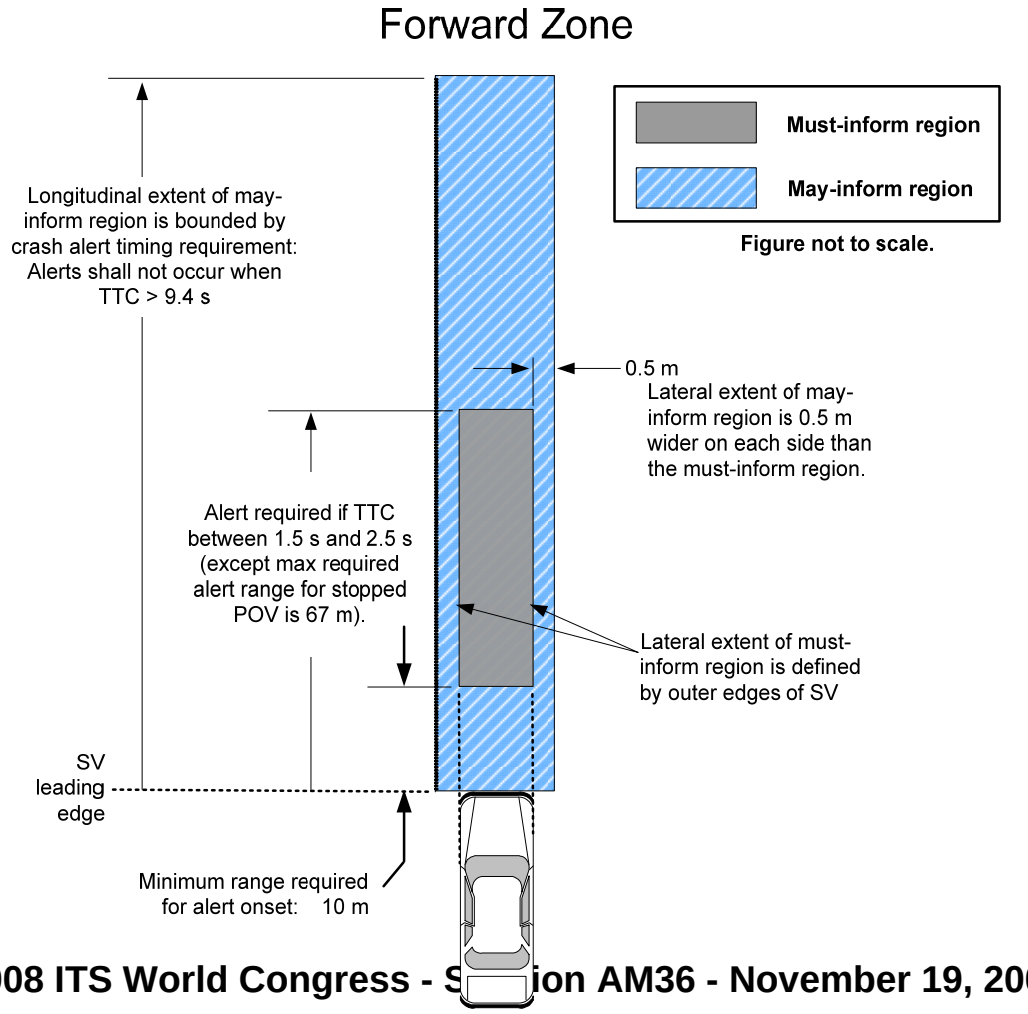


Bounds on the location of the lateral drift crash alert threshold relative to the lane boundary

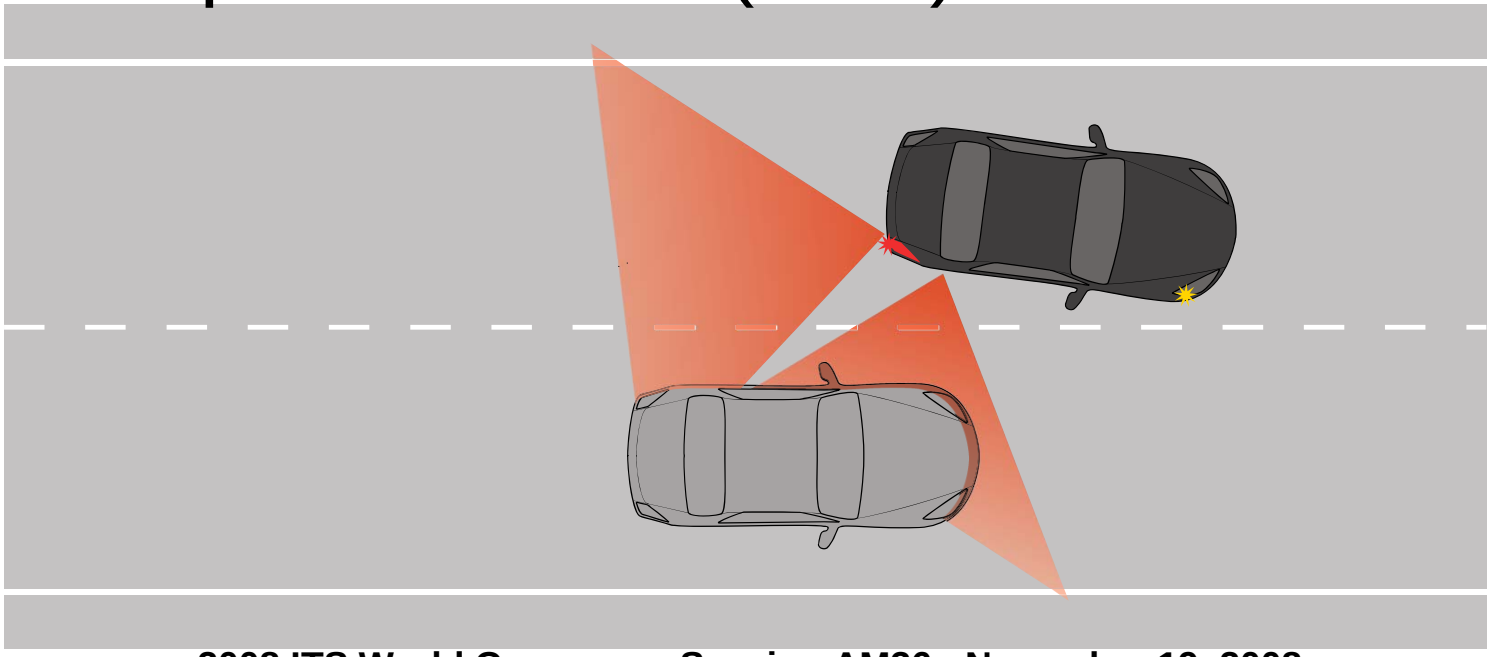
	d_E	d_L
When confident that no crash threat (object) is near or just beyond lane edge	0.5 m	0.75 m
Nominal	0.5 m	0.5 m
When confident that crash threat (object) is near lane edge	0.75 m	0.5 m

FCW Warning Zone



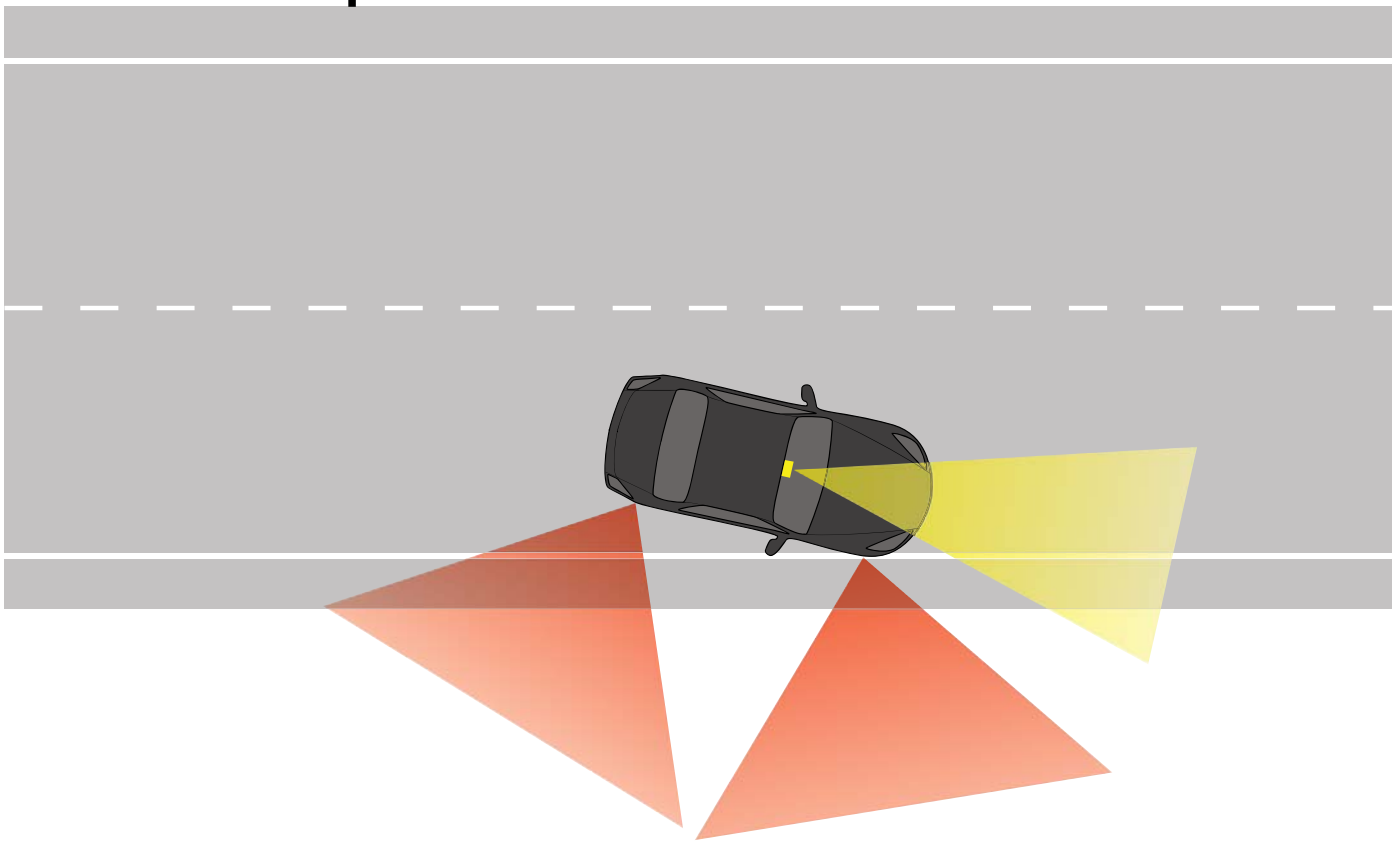
LCM/LDW Description

- LCM incorporated Time-to-Collision algorithm
- Blind Spot Detection (BSD)



LCM/LDW Description

- LDW incorporated Time-to-Line-Crossing



LCM/LDW Description

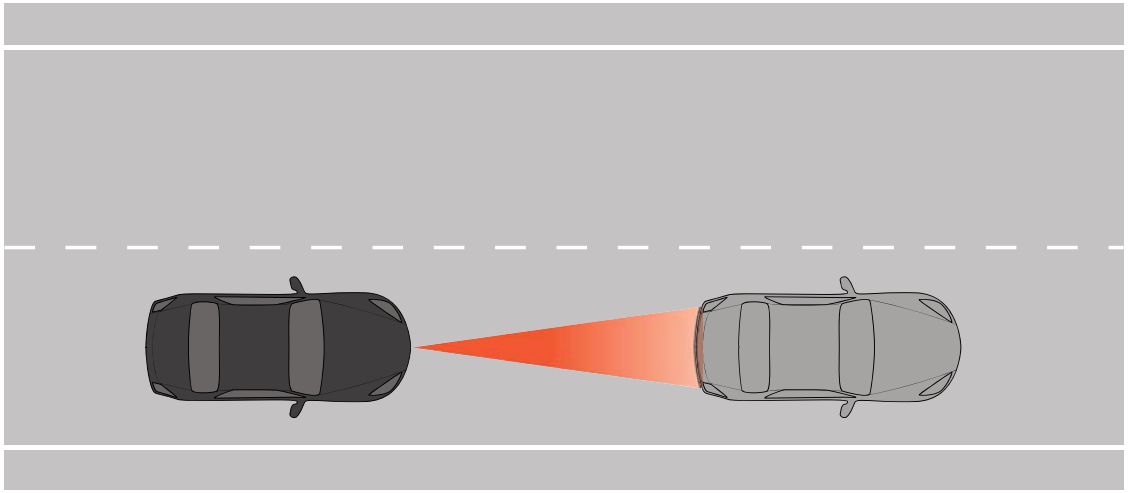
- Works together by sharing radar and vision information
  - LCM calculates Available Maneuvering Room and shares with LDW
    - Six short-range radar sensors
  - LDW shares position in lane with LCM
    - Forward CMOS camera
- Same warning for LCM and LDW imminent
  - Directional auditory cue
  - LDW cautionary directional haptic cue in seat

LCM/LDW Description

- Other Subsystem Interactions
  - LDW uses information from FCW to:
    - Adjust the warning threshold while traversing a curve
    - Better track the lane boundaries (better predictor of where to look in the field of view)
    - Disable the system if too close to the vehicle ahead
  - LDW uses road class from the map data from CSW to determine the appropriate default Available Maneuvering Room (AMR) value and to potentially adjust the AMR value being reported by LCM

FCW Description

- Uses long-range radar sensor, yaw rate sensor and map information from CSW
- Improved radar processing techniques to improve object detection and rejection
  - Better stopped object performance while maintaining low false alarm rate
  - Allows deletion of additional vision system to augment radar data

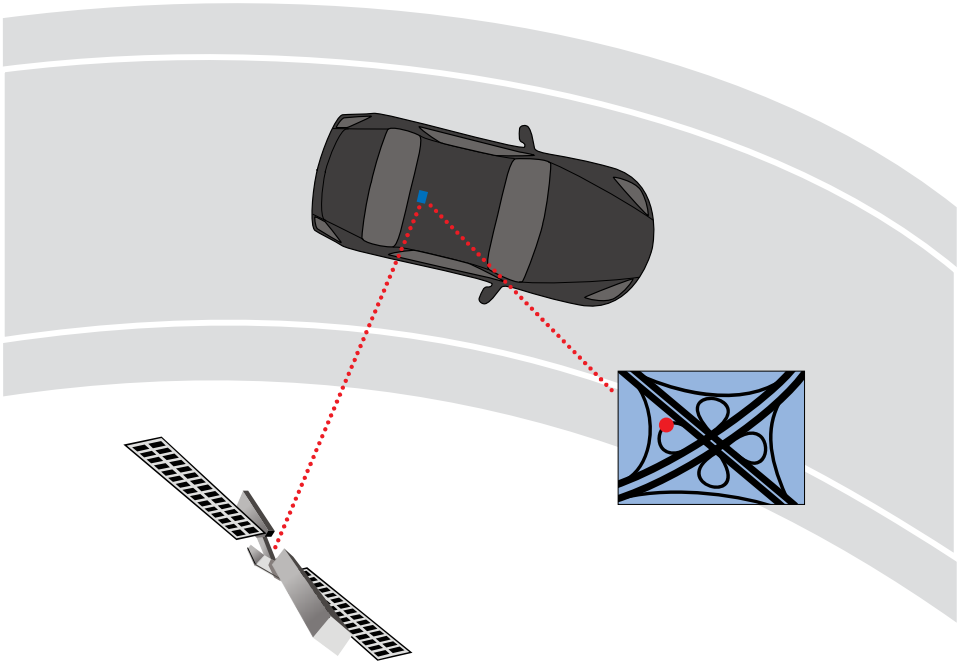


FCW Description

- Interaction with other subystems
  - FCW uses map database attributes and Most-Likely Path attributes from CSW for path prediction and primary target selection
  - FCW calculates and sends the following data for use by other subsystem:
    - Refined curvature based on scene tracking and CSW curvature values
    - Primary target information, such as headway

CSW Description

- Uses digital map combined with vehicle state signals
- Developed and implement a False Alarm Database (FADB)



CSW Description

- Interaction with other subsystems
  - Provides the GPS latitude and longitude information
  - Provides the road geometry and road attributes to the other subsystems
  - Uses lane boundary type from LDW as an input for the Most-Likely Path calculation

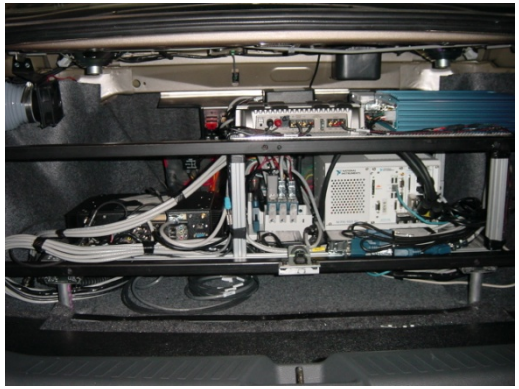
Arbitration and DVI Description

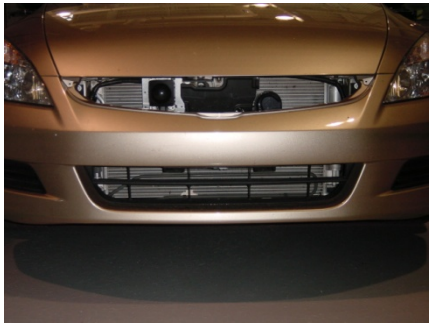
- Arbitration Subsystem
  - Rule-based for multiple threat scenarios
    - Do not repeat warnings within 3 seconds (15 seconds for CSW)
    - Give competing warnings immediately after 1st warning is complete (710 ms)
    - Ignore lower priority warnings
    - Only 2 warnings maximum for any given multiple-threat scenario
- DVI Subsystem
  - Integrated warning strategy

DVI Description

	Forward Alerts		Lateral Alerts		
	FCW	**CSW**	**LCM**	**LDW Imminent**	**LDW Cautionary**
Auditory	Tone 1		(L) (R) Tone 2		____
Haptic	Brake Pulse	____	____		Haptic Seat L/R
Visual	____		Blind/Closing Zone: Yellow		____
Warning Text	Hazard Ahead	Sharp Curve	Left/Right Hazard		Left/Right Drift
Availability	____	____	____	____	____
System Disabled	IVBSS OFF				
Service	IVBSS Service Required with Tone 3				
Other Service Messages	Clean Front Grill	____	Clean Front/Rear Bumper	Clean Windshield	

Vehicle Integration





FOT Vehicle Builds

- 16 Vehicle Fleet
  - 12 new builds
  - 4 retrofitted development vehicles
- 6 FOT vehicles complete
- 2 in check-out
- 8 in progress